Remarks/Arguments:

The present invention relates to a consumable electrode welding machine including a resistance calculator for calculating and outputting a resistance signal. The resistance signal is delivered to a short-circuit waveform control circuit and an arc waveform control circuit for controlling a welding power through control of voltage in a short-circuit state.

Claims 1-8 are presently pending in the application. In this amendment, Claims 1-8 are amended and presented for reconsideration.

Claims 1-8 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite. Claims 1-8 have been appropriately amended. Withdrawal of the objection is respectfully requested.

Claims 1-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over JP Patent Publication No. 410109163 A (hereinafter "Kawamoto") in view of U.S. Patent No. 6,248,976 B1 (hereinafter "Blankenship"), U.S. Patent No. 1,687,492 (hereinafter "Churchward") and U.S. Patent No. 4,518,844 (hereinafter "Needham"). Applicants respectfully traverse this rejection for at least the reasons set forth below.

Needham is newly cited. Needham is drawn to a method and apparatus for short-circuit MIG welding including a monitoring means. The monitoring means is provided for monitoring the ratio (M) of one of the mean and successive integral of the arc duration to the corresponding one of the mean and the successive integral of the short-circuit duration.

Applicants' invention, as recited by claim 1 includes a feature which is neither disclosed nor suggested by the art of record, namely:

> ... the machine further **comprises a resistance calculator** for calculating a resistance signal based on the welding voltage detection signal and the welding current detection signal, and the resistance signal is delivered to the short-circuit waveform control circuit and the arc waveform control circuit for controlling the welding power, wherein,

> when the short-circuit arc judgment circuit judges the machine is **in the short-circuit state**, the short-circuit waveform control circuit **controls the welding voltage to decrease** when the resistance signal exceeds a first resistance threshold**, controls the welding voltage to increase** and the short-circuit period to decrease when the resistance signal is below the first resistance threshold ...

This feature describes the welding machine including control of voltage in the short-circuit period. The welding machine first calculates the resistance signal based on the welding voltage and current detection signals in a short-circuit period and in an arc period. In this process, when the machine is in the short-circuit state, the welding voltage is controlled to decrease when the resistance signal exceeds a first resistance threshold, whereas the welding voltage is controlled to increase when the resistance signal is below the first resistance threshold. Then, the resistance signal is delivered to the short-circuit waveform control circuit and the arc waveform control circuit for controlling the welding power. This feature is found in Applicants' published specification at paragraph [0049] lines 5-13, paragraph [0050], lines 4-9. No new matter has been added.

Regarding independent claim 1, Kawamoto is relied upon, on page 6 of the Office Action, as disclosing all the features of claim 1, except for a resistance calculator. The Examiner asserts on page 9 of the Office Action that Blankenship, Churchward and Needham teach what Kawamoto lacks. Applicants respectfully **disagree** with the Examiner's overly broad interpretation of the cited art.

As described at paragraphs [0002-0003] of the English translation of Kawamoto, in a conventional direct-current arc welding machine for welding by generating a direct-current arc between a wire and a base metal, it is common to control the voltage in an arc period, and control the current in a short-circuit period (see Welding Junction Handbook Section 2, ed. Japan Welding Society). Kawamoto further discloses at paragraphs [0004-0006] an output control method that executes a fixed current control in which a gradually decreased welding current value after arc recurrence time is increased up to a high value when a given time has passed from the arc recurrence time, thereby controlling the occurrence of a short circuit just after arc recurrence and thus reducing the generation of the welding slags. Accordingly, Kawamoto teaches **control of**

current in a short-circuit period and does **not teach** or suggest control of voltage in a short-circuit period.

Blankenship, in col. 2, lines 6-38, discloses the concept of sensing the derivative of voltage with respect to current, a parameter (*dV/dI*) used to determine the voltage across the arc as well as maintaining the length of the arc in an arc welding process. The signal *dV/dI* relates to the total resistance R_{ESO}+R_{arc} across CTWD (Contact Tip to Weld Distance). Due to the low relative magnitude of R_{ESO}, the *dV/dI* signal is primarily a representation of the arc resistance in an arc welding process. Further, the signal *dV/dI* does not equal the load resistance obtained by merely dividing welding voltage by welding current on a real time basis. The signal *dV/dI* relates to the concept of sensing the derivative of voltage with respect to current to give a resistance function that ignores current. Accordingly, Blankenship teaches **control of the signal *dV/dI* to determine the voltage in an arc** period and does **not teach** or suggest control of voltage in a short-circuit period.

Churchward, at page 1 line 67-page 2 line 35, discloses a welding device that maintains a constant current across the arc by supplying a greater voltage when the arc resistance is increased. Accordingly, Churchward teaches **control of voltage in an arc** but does **not** teach or suggest control of voltage in a short-circuit period.

Needham discloses a welding device that monitors a ratio M defined as the ratio of the mean of the arc duration to the mean of the short-circuit duration and maintains the ratio M substantially constant. This may be achieved by feeding back the monitored value of M to control means operating on the power supply, the welding circuit, or wire feed means to maintain the value of M at a desired average level. Needham, in col. 2, lines 46-57, discloses that "attempts have been made in the past to effect such control for example by controlling the average supply voltage. **However**, the degree of control is limited as the short-circuiting frequency is not an absolute function of the voltage, being influenced also by the weld pool and welding conditions ... Thus it is preferred to influence frequency (at a given M value) by adjustment of the inductance and where applicable to the current level at which it saturates significantly." (Emphasis added) Accordingly, Needham teaches **adjustment of the inductance** and where applicable to the **current**

level in the short-circuit duration but does **not** teach or suggest control of voltage in a short-circuit period.

Furthermore, Needham, in col. 3, lines 22-37, discloses that regarding synchronization between the modulation of the power supply and the short-circuit behavior, "with respect to open circuit voltage alone, the voltage can be increased immediately on the onset of the short-circuit or after an initial delay of say 1 ms, and likewise during the arcing period the voltage can be reduced, particularly after a finite period measured from the start of the short-circuit cycle or alternatively from the start of arcing such that fall in voltage occurs towards the end of the expected cycle period." This disclosure describes the behavior of the voltage in the short-circuit period and the arcing period, and is **not related to control of the voltage**. Accordingly, Needham does **not** teach or suggest control of voltage in a short-circuit period.

The combination of Kawamoto, Blankenship, Churchward and Needham is different from the Applicants' claim 1, because as discussed above, Applicants claim 1 requires that the welding machine further includes "a resistance calculator for calculating a resistance signal based on the welding voltage detection signal and the welding current detection signal, and the resistance signal is delivered to the short-circuit waveform control circuit and the arc waveform control circuit for controlling the welding power, wherein, when the short-circuit arc judgment circuit judges the machine is in the short-circuit state, the short-circuit waveform control circuit controls the welding voltage to decrease when the resistance signal exceeds a first resistance threshold, controls the welding voltage to increase and the short-circuit period to decrease when the resistance signal is below the first resistance threshold." This is different from Kawamoto because Kawamoto, as admitted in the Office Action, fails to disclose an resistance calculator. Furthermore, Kawamoto does not teach or suggest control of voltage in a short-circuit period.

Additionally, Blankenship, Churchward and Needham fail to overcome the deficiencies of Kawamoto. As discussed above, Blankenship, Churchward and Needham do not teach or suggest control of voltage in a short-circuit period. Therefore, Blankenship, Churchward and Needham fail to make up for the deficiencies discussed above in Kawamoto.

Accordingly, Kawamoto in view of Blankenship or Churchward or Needham fails to disclose, teach or suggest each and every feature of Applicants' claim 1.

It is **because** Applicants include the feature of the welding machine including "a resistance calculator for calculating a resistance signal based on the welding voltage detection signal and the welding current detection signal ... wherein, when the machine is in the short-circuit state, the welding voltage is controlled", which the following advantages are achieved. As described on page 3, paragraph [0051], lines 27-34, the welding voltage can prevent sputtering phenomenon, or, can prevent possible problems, such as buckling of the wire.

Accordingly, for at least the reasons set forth above, claim 1 is patentable over the art of record. Claims 2-4 include all of the features of claim 1 from which they depend. Thus claims 2-4 are also patentable over the art of record for at least the reasons set forth above.

Claim 5, while not identical to claim 1, includes features similar to claim 1. Accordingly, claim 5 is also patentable over the art for at least the reasons set forth above with respect to claim 1. Claims 6-8 include all of the features of claim 5 from which they depend. Thus claims 6-8 are also patentable over the art of record for at least the reasons set forth above.

In view of the amendments and arguments set forth above, the above-identified application is in condition for allowance which action is respectfully requested.

Respectfully submitted,

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